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The Ice Age

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THE ICE AGE.

WHEN CONYERS FOUND AN ELEPHANT.

Old John Conyers was an apothecary in London town in the days of that "old goat," Charles II, and he did not have his heart in his profession. His delight was to poke about in odd places collecting antiquities. After the great fire of London he was in his seventh heaven of delight. Wherever there was an excavation for building, wherever men were at work clearing out rubbish, Mr. Conyer was to the fore. His most famous find came in the year 1680, when, inspecting some gravel heaps for odd shaped stones, he discovered the remains of what seemed to be the skeleton of an elephant. Nearby, he found flints—spear heads and a few arrow tips. So, the fragments having been placed in safe keeping, it became the turn of the theorists to explain. There was some keen discussion, and the learned old gentlemen of the Royal Society were at some trouble to account for the phenomenon. For, as you have no doubt noticed, the mind of man is so constituted that there is little content until a guess is made as to causes, and, by some means or other, an infallible authority set up. Then there is pause for awhile and until some doughtier disputant arises. Certainly, man clings to his theories, and the older the theory, the tougher it becomes, and the harder it dies. Hence the conflict between re-

ligion and science. As Huxley once said, the great tragedy is to have a theory slain by a fact.

The theory advanced to account for the "elephant" bones was that perhaps, in the reign of the Emperor Claudius, the Romans had shipped elephants to Britain and one of them had been killed in battle. Someone else produced Seldon's notes on the Polyolbion which seemed to show that a battle had been fought thereabouts, and so the theory seemed well supported and thus stood for many years.

All things considered, it was an excellent guess and did very well, for in those days the world and its phenomena seemed less complex than now. You recall Samuel Pepys once pondering on music which he had but recently heard, and setting down the reflection that "it made me think on the great age of the world." The "great age," according to his knowledge and belief, was a little over five thousand years. That the stream of life reached very much further, neither Pepys nor his friends dimly suspected. Indeed, authorities would have looked with disfavor upon anyone rash enough to say that the world was more than four thousand years old at the birth of Christ. There were, to be sure, foreign fellows, "absurd disturbers," endeavoring to undermine accepted theories in other departments of knowledge. There was Galileo for instance, who, a few years before, had written a book on "The System of the World," but it was well known and gleefully told that on his knees he had recanted, and, in the torture

chamber, had cursed the doctrine of the movement of the earth around the sun. Then, too, Bruno had lectured in England on the plurality of worlds, and in the days of Pepys there were still men who had heard their fathers tell of that dark day in February, in 1600, when the black smoke rolled heavy wreathed, as Bruno died. So, on the whole, it was very safe to accept the chronology of the authorities and have done with it.

INTO THE PAST.

Now it was but the other day that I fell to reading a story by H. G. Wells, in which he pictured a man's travels in time, into the very remote future. This man was made to invent a machine, and, when he pressed a lever, "the night came like the turning out of a lamp, and in another moment came tomorrow." As he sat, always in the same place, but moving in time, "day followed night, like the flap, flap, flap of some rotating body" and he saw the sun "hopping swiftly across the sky, leaping it every minute, and every minute marking a day." The tale held me fascinated, and I imagined myself using some such machine in company with Pepys and John Conyers, but, instead of going onward in time, we would have gone backward. I played with the idea and supposed that the three of us had started when the bones of the "elephant" were found, and, with us also, every minute had marked a day. Watching the dial, Pepys and Conyers would have grown very nervous after a four years' trip, for then, according to their chronology, we should have fallen into illimitable

darkness and all things would have been without form and void, and the heavens black and empty. But looking, we would have seen that it was not so. We would have seen that men walked the earth and that cities and nations flourished in far lands, in Persia and Babylonia, in Egypt and China. And still the earth would be fair, and, as we traveled, year after year, and "each minute marking a day," we would see summer furling and unfurling her banners of green. Ten, fifteen, twenty years we would fly in time and our own day would be left behind thirty thousand years. Then would come the change. We would see the green belt of summer narrowed to a mere strip, and glittering snows would lie where life had teemed, and ice would tower, mountain above mountain. Into a mighty night of winter we would leap and our hearts would fall for that earth was dead. The sun would pale and there would rush out new and strange stars. For gray centuries there would be snow clouds and leaden skies, and the tortured earth would groan at the weight of slow pressing ice. Twice ten thousand years and the winter endured; but still man was.

For nigh thirty thousand years, generation of man succeeded generation knowing not what we call warmth. Then again the earth was fair; again the sun clothed it with gold and green, and the ice cap shrank back to the pole. From the sea, islands grew and on the islands great mountains reared their heads. Continents changed their shapes, now advancing, now receding. Lakes became seas

and other seas dwindled, and volcanoes that spouted fire were swallowed up. Vast plains were tilted and the ocean bed sprang up like a mighty shield. It was as though the earth had lost its stability and had become the plaything of mocking genii. For a thousand generations it was thus. For a hundred thousand years the heavens were kind so that the memory of man knew nothing of cold, of the fierce blasts that once drove his ancestors to dark holes.

But again there came a time when darkness and cold imprisoned the earth. Again the world sickened. There were thunderings of ice, and mighty glaciers slid into the ocean. For thousands of years, creatures fled before the snow to kinder climes. Under the weight of slow moving ice, mountains were riven and crushed and changed into stones. Great lakes were filled with debris and river courses blotted out. For forty thousand years what had been a verdant home for a million living creatures was a pallid corpse.

Once more the sun kissed the earth, the shroud was cast aside and the first whisper of life swelled to a chorus of joy. Nameless monsters walked the earth, and fell, slain by man who had crept from his hiding place. So, for the space of a hundred and fifty thousand years, blessed with sunshine and rain, earth was green and beautiful, and fair attired. The winters too were kind. And the abyss of time that stretched between then and now, was three hundred and fifty thousand years.

Into another phantom winter the earth slid,

and for a space of fifty thousand years there was white silence. Beasts hoary with rime trod the earth and sheeted mountains threatened the leaden clouds. Into the past, into the past four hundred thousand years from the day when John Conyers found his "elephant!" For the beast whose bones he found had lived when the earth was young, if indeed it was ever young.

Nor did the ice sheet shrink back within its normal confines or a genial climate return to revivify the newly uncovered earth, until a new fifty thousand years had passed. Then, again the world was plunged into a mighty summer cycle. Sometimes, in places, for hundreds of years, there were rains that fell incessantly, so that hills and rocky headlands melted like wet salt and vast steam clouds lifted themselves to heaven. Great beasts of vile shapes floundered in vast marsh lands, and monstrous horned things lifted their heads and shook the hills with deep organ tones. At the sound, the naked thing that walked on two legs, the flat-faced beast that was a little less than man and a little more than ape, came from its hiding place making queer noises. And those noises other like creatures understood, so that they came creeping, and the hunted thing knew not which way to turn and so fell a prey to the red haired pigmy, the weakest of living things, the slowest of living things.

HOW OLD IS MAN?

It is fascinating: there is might, majesty and immensity in the dream that takes us back to the first known glacial epoch of a half million

years ago. It is a dream that fills us with astonishment and with awe, if, indeed, it does not make dizzy the brain. That John Conyers' "elephant," a mighty mammoth, might have wandered with tens of thousands of his kind, wandered from north to south, over lands that are now seas, over tundras where are now mountains, might well seem to the old apothecary an idle dream. Indeed, to him and to his fellows, it would have been as the ravings of a madman had one said that there was a day when England was not a "tight little island," but, instead, a solid part of the continent, a high land indeed, to the west of a great valley which separated it from the Scandinavian peninsula, and that the Thames river on the banks of which he made his find, was itself then but a tributary to a greater Rhine which again joined the Elbe and finally emptied into what is now the Arctic Ocean. Indeed, all men at all times are most unwilling to be convinced against experience, we, of our own time, no less than Conyers in his. To me, the vast antiquity of man came as a shock. I had known from books something of man in the dawn of history, in the days when Greek and Pheonecian came in contact, and, in a lecture by Sir Robert Ball, I, a student, had picked up a glimmering knowledge of the Ice Age. But that man had existed through a single glacial period I had no notion. It took years and years of reading to thoroughly grasp that fact. Then, through the writing of Henry Fairfield Osborn, I came to see things in a new and strange light. Like onward sweeping waves race after

race had moved, to die and be known no more. Thirty thousand years ago, in comparatively recent times, geologically speaking, there were races of men living side by side—the Cro-Magnons, the Brunn race, the Ofnet race. Some had existed through the last glacial period. Some had vanished during its reign. Looking back and into the interglacial period before that, into what is known as the Lower Palaeolithic, fifty thousand, seventy-five thousand years ago, we find still other races—the Piltdown man, the Neanderthal man. Back still further, into the Third Glacial, still further into the Second Interglacial, a quarter of a million years ago, and there is the Heidelburg man—further back still, the Trinil race. Then we seem to come to the time of the pre-human species, the common ancestors of extinct and existing races of man.

To visualize, as far as possible, the time periods, as they would seem to exist from glacial stage to glacial stage, I give a table avoiding as far as possible all that would tend to confuse:

	Years Duration	Years From Our Time
Postglacial: Cro-Magnon Race..	25,000	25,000
Glacial Stage: Neanderthal Man.	25,000	50,000
Interglacial Stage: Piltdown Man.	100,000	150,000
Glacial Stage	25,000	175,000
Interglacial Stage: Heidelburg Race	200,000	355,000
Glacial Stage	25,000	400,000
Interglacial Stage: Trinil Race..	75,000	475,000
Glacial Stage	25,000	500,000

NO AMERICAN ANCIENTS.

These human discoveries, as will presently be seen, are all from the eastern hemisphere. There have been reported finds of some supposed antiquity on the American continent, notably the "Calaveras" skull in California, the "Fossil" man of Vero, Florida, and the man of Cuzco, Peru. But there is much doubt as to whether man existed in far times in the western hemisphere. For highly interesting reading on the subject, you are referred to a little book published by the Bureau of American Ethnology. It is Bulletin 66, entitled "Recent Discoveries Attributed to Early Man in America" and the author is Ales Hrdlicka. As the publication may be difficult to obtain, for it appeared in 1918, I quote, as important and interesting, from pages 37 and 38:

"In considering the problem of human antiquity in any region, anthropology must take into consideration the broader aspects of the case and ask, whether, in the light of our actual knowledge, the presence of man in that region during the specified geological time was probable or even possible. This is of especial importance on the American Continent for the reason that man here is not autochthonous, but must have immigrated from some other part of the earth. Thus the first question to be considered in every case on this continent where we are confronted with the problem of man's antiquity is, Could man have been present in the locality in question, or even in America, during the period to which the finds seem to belong or are being attributed? This difficult question fortunately can be met with something more than mere hypothesis.

"According to all indisputable evidence which we now possess, man's age is well comprised within the Pleistocene and Recent periods; that

is within possibly 500,000 to 600,000 years. By far the larger part of this time, however, was required for his cultural development, physical differentiation, multiplication in numbers, acclimitization to new environments and his spread over the immense territories of the Old Word, the warmer parts of which were his cradle. Before all these results were accomplished or were far advanced, man evidently could not have reached the distant, isolated New World; and there is much evidence that this was not reached until very late in man's history, in postglacial times or at the earliest toward the end of the Quaternary. As late as the Aurignacean culture period, approximately 15,000 to 25,000 years ago, man had not yet fully reached modern standards in physical development, had made no pottery, knew no metals, did not extend to northern Europe, left no evidence that he knew even the crudest navigation, and could not possibly be conceived of as having been numerous enough to reach the northeasternmost limits of Asia, from which alone there was a practical way open to the American Continent. How could we have, then, in this country man of even much greater antiquity? These considerations can not be easily passed over. They rest on a mass of realities and would have to be completely explained away before anthropology could admit the presence of geologically early man in the New World.

"Still another consideration is that, had man reached the American Continent in early times and spread over it so as to reach the outlying regions, such as Florida, he would necessarily have been represented here by large numbers. But large numbers of even nomadic tribes could not but leave numerous material traces over wide areas, some of which at least by this time would have been discovered. As it is, however, we have not a single fact, not a single specimen, to prove the existence in America of any such ancient population. There are on record a number of reports of the finding of ancient remains in both North America and South America; but

on critical study by archeologists and anthropologists the claims made have invariably proved to be doubtful, or without any scientific foundation. Most of the reports are simple errors, while others merely represent cases in which the circumstances of the find were such that no definite proof as to the age of the remains will ever be possible one way or the other. Outside of these cases there is a great void."

The same writer in his "Skeletal Remains Suggesting or Attributed to Early Man in North America," (Smithsonian Institute—Bulletin No. 33) says: "thus far on this continent no human bones of undisputed antiquity are known." Osborn, in his Age of Mammals, page 499, discusses the finds, listing them thus: the Natchez (Mississippi) pelvic bone (1846), the Calaveras (California) skull (1866), the Trenton (New Jersey) skulls (1879, 1887), the Lansing (Kansas) skeleton (1902) and the Nebraska 'loess man" (1894, 1906). He holds that "in some instances association of the human bones with those of extinct animals is due to intrusive burials, that is, burials in which the grave happened to be carried below the stratum containing a number of extinct forms. The Natchez plevic bone may be a case of accidental association of a bone fallen from an Indian grave and mingled with older fossilized bones. The famous Calaveras skull agrees closely with the cave skulls from Calaveras County geologically of recent age. The Trenton crania found in glacial gravels along the Delaware river are of doubtful geological age, while their anatomical characters are not those of the Delaware Lenape Indians recently inhabiting the district, but appear of relatively modern and European

origin. The Lansing skeleton found twenty feet below the surface in the loess-like silt was heralded as a find of real geologic antiquity, but proves to agree closely with the typical upper Mississippi Valley Indian of the present day. Similarly, the fossil human bones from the west coast of Florida show a marked anatomical likeness to recent Indian bones. The Nebraska loess man, which was regarded as primitive, proves to correspond in its low forehead with certain low-type Indian crania, such as are found among the mound-builders of Arkansas and even among certain recent Indians."

We may then, discard all American finds, considering the Old World alone.

It is very necessary to picture, not a steadily settled race, not a group of peoples attached to one part of the world, but rather a constantly moving stream, advancing and receding as the cold periods grew or decreased. There would be constant migration of mammals, moving, generation after generation, back and forth, a part of the ceaseless rhythm that marks all things. During the warmth of the inter-glacial period, from Africa and from Asia there would be the home of the hippopotamus, the southern mammoth, the lion, jackal, hyena and the terrible sabre toother tiger. Then, again, during the Glacial epoch, hardier animals, fur bearing mammals such as the musk ox, the reindeer or the woolly mammoth would find their way to lands now known to us as warm or temperate. The fossil remains of these mingled with those of man have told their story.

ART IN THE POST GLACIAL.

It is a curious thing that thirty thousand years ago, men in the stone age drew on the walls of caves, and engraved on ivory tusks, the pictures of animals familiar to them, and did the work much better than many men, living in our own day, could do. It seems very evident that the purpose of the prehistoric artist was to beautify his cave, and, it must be observed, the pictures and engravings were done with consummate skill. I have before me, a careful reproduction of the artistic work in the caves of the Dordogne. Here is one, a sketch done on a piece of antler, showing a wild ox feeding. Behind him is a creeping man with spear poised to throw. Another sketch shows a naked hunter casting a spear at a horse. Still another shows a mammoth. It is done on a piece of ivory and the artist has taken pains to mark the shaggy ears of the animal, its upward curved tusks, and the high grass which hid the feet. Scratched on a piece of slate is a group of reindeer. The animals are perfectly proportioned and the details of the antlers shown. From the grotto of Gourdan, on the upper Garonne, came a fragment of reindeer horn with the heads of four reindeer engraven thereon. In Osborn's "Men of the Stone Age," page 437, is an illustration of a necklace of marine shells from the cave of Cro-Magnon. The remains of similar ornaments made of small plates of ivory and the perforated teeth of cave bear were found with an ancient skeleton in a cave in Paviland, Wales. Other notable finds were, a statuette

carved from a fragment of mammoth tusk representing a horse with erect mane: the head of a woman with head dress, sculptured in ivory: small human figurines in the form of statuettes in bone and ivory; two bison, male and female, modelled in clay, the length of each figure being about two feet. As to this latter, I quote a letter written by the archeologist, Comte de Begouen, dated October 23, 1912:

"Today, I am happy to give excellent news from the cavern, Tuc d' Audubert. As you, (Henry Fairfield Osborn) were the first to visit this cavern, you will also be the first to learn that in an upper gallery, very difficult of access, at the summit of a very long ascending passage, and after having been obliged to break a great number of stalactites which completely closed the entrance, my son and myself have found two superb statuettes in clay, about 60 cm. in length, absolutely unbroken, and representing bison. Cartailhac and Breuil, who have come to see them, were filled with enthusiasm. The ground of these chambers was covered with imprints of the claws of the bear, skeletons of which were buried here and there. The Magdalenians have passed through this ossuary and have drawn out all the canine teeth to make ornaments of them. Their steps left their fine impressions on the humid and soft clay, and we still see the outlines of several bare human feet. They had also lost several flakes of flint and the tooth of an ox, pierced at the neck; we have collected them, and it seems as if they had only dropped yesterday; the Magdelenians also left an incomplete model of a bison and some lumps of kneaded clay which still carry the impression of their fingers. We produce the proof that in this period all branches of art were cultivated."

Of the clay bison model, Cartailhac is quoted by Osborn as having declared them "of perfect workmanship and of ideal art."

THE CRO-MAGNONS.

A people thus given to art, must have been skilled in domestics. Edward Clodd, in his "Primitive Man," page 57, tells of the love of ornament, as evinced by "the rouge pot, in the shape of oxide of iron." But Clodd wrote in 1897, and it was not until the year 1906 that the great discovery was made in the cavern of Niaux. That proved, beyond a doubt, that colors were used by the men of the Stone Age for art purposes. At times, four colors were used, and a complete polychromic fresco art brought to a high stage of development. Osborn found that ochre and oxide of manganese were pounded together in stone mortars and that paint was made with the powder mixed with animal oils and fats. And animal oils and fats of course suggested other things. For instance when stone lamps were found in the grotto of La Mouthe by E. Riviere, it was seen that there remained in the bowl some carbonized matter. The chemist, Berthelot, analyzed this sediment and concluded that animal fat was used for lighting purposes. So, each and every one is free to theorize. You have an advanced form of art, head dresses, neck ornament, lamps in which animals oils and therefore wicks were used, bas-reliefs and sculptured ornaments. Horses were represented without forelocks and with erect manes, which would seem to indicate clipping, and, therefore, domesticated animals, for no one would clip the manes of wild horses. And bone needles would certainly suggest sewing of a kind, and sewing, in turn, clothing.

I am the more inclined to hold to the idea that the Cro-Magnons had domesticated animals, seeing that the lowest race now living, lowest in point of civilization, the Ooans of Tierra del Fuego, have partly domesticated dogs, while the Esquimau, who lives in a climate approximately the glacial, uses reindeer. On the other hand, Professor McNair, of the University of Arkansas, holds that the Cro-Magnons emigrated westward and with him went herds of wild animals of Asiatic origin, among which were short maned horses, and with the appearance of those, the Cro Magnons would be familiar. That, of course, seems perfectly logical and reasonable.

These people of what is now known as the Cro-Magnon race, a race that flourished in Upper Palaeolithic times, lived side by side for a period with the Neanderthals. Doubtless, they brought their civilization from the east whence they came, driven from their own land by the pressure of population, it may be, or, perhaps, journeying westward because of a conquering, or adventurous spirit. The Cro-Magnons would seem to have been a finely proportioned, well built people. Osborn mentions a skeleton taken from the Grotte des Enfants, found among reindeer bones 15 feet below the surface, which measured 6 feet 4½ inches. This was exceptional, and he holds it probable that it was of a man antedating the Cro-Magnons. But he gives the heights of other discovered skeletons as follows:

Cro-Magnon of Dordogne...5 feet, 10¾ inches
Adult male of Cavillon.....5 feet, 10½ inches

Barma Grande II.....5 feet, 11½ inches
Baousso da Torre II.....6 feet, ¾ inches
Barma Grande I.....6 feet, 4 inches
making a general average of 5 feet, 5 inches.

The Cro-Magnon man was first discovered in 1868 by Lartet when workmen, building a road in the Vezere Valley uncovered a grotto containing five skeletons. P. Broca, in his "Sur les cranes et ossements des Eyzics," (Bulletin Societe d'Anthropologie, Series 2, Tome III, pp, 350-392) adduced these human remains as positive proof that man and the mammoth were contemporaries. He held that the shape of the skull showed large brain capacity, and said that the brain capacity of the Cro-Magnon surpassed that of the average male of today. A. Keith described the Cro-Magnon as "the finest race the world has ever seen." (See, Ancient Types of Man—Harper's Library of Living Thought. New York, 1911). The general conclusion seems to be that the characteristics of the race were akin to those of certain highly advanced Himalayan tribes. The restoration of the head of the "old man of Cro-Magnon" shows a strong profile, a nose decidedly acquiline, square chin and high forehead. Seen from the front the face might be the face of a modern philosopher, a Herbert Spencer or some determined Roman emperor. The cheek bones are very broad and high.

I quote from Osborn's "Men of the Stone Age," page 272. "There is evidence of various times that the Cro-Magnons arrived in Western Europe, bringing in their Aurigncian industry, while the Neanderthals were still in

possession of the country and practicing their Mousterian industry. . . . Whether the Neanderthals were exterminated entirely or whether they were driven out of the country, is not known; the encounter was certainly between a very superior people, both physically and mentally, who possibly had the use of the bow and arrow, and a very inferior and somewhat degenerate people that had been already reduced physically and perhaps numerically by the severe climatic conditions of the fourth glaciation. The Neanderthals were dispossessed of all their dwelling places and industrial stations by this new and vigorous race. . . .

"In the racial replacements of savage as well as of historic peoples the men are often killed and the women spared and taken into families of the warriors, but no evidence has thus far been found that even the Neanderthal women were spared or allowed to remain in the country, because in none of the burials of Auringian times is there any evidence of the crossing or admixture of the Cro-Magnons and the Neanderthals."

"The chief source of the change which swept over western Europe lay in the brain power of the Cro-Magnons, as seen not only in the large size of the brain as a whole, but principally in the almost modern forehead and forebrain. It was a race which had evolved in Asia and which was in no way connected with the Neanderthals; a race with a brain capable of ideas, of reasoning, of imagination, and more highly endowed with artistic sense and ability than any uncivilized race which has ever been dis-

covered. No trace of artistic instinct whatever has been found among the Neanderthals. . . . After prolonged study of the works of the Cro-Magnons one cannot avoid the conclusions that their capacity was nearly if not quite as high as our own; that they were capable of advanced educations; that they had a strongly developed aesthetic as well as a religious sense; that their society was quite highly differentiated along the lines of talent for work of different times."

So, it is fair to assume that the Cro-Magnons wiped out their predecessors, the Neanderthals. One does not view the disappearance of any race without regret. Still, the struggle of humans against the forces of nature also involves an objection to any other society wasting natural resources. Therefore, we must, in some sort, recognize it as a weak humanitarianism which regrets that a capable and a stalwart race should replace a race that can neither utilize things for the full benefit of mankind, nor contribute its quota to the common stock of human knowledge. But the same lurking curiosity that leads us to explore the history of the ancient Britons when the Romans drove them from their land, also makes us inquisitive about the Neanderthals who lived during, and before the Fourth Glacial Epoch.

In this connection, a book just off the press, "Warfare in the Human Body" by Morley Roberts, (E. P. Dutton and Co., 1922), has an interesting passage. The author holds that it is to be accounted quite possible that the disappearance of such a species of humanity as

Neanderthal man may be laid to cannibalism, for, while the evidence of the teeth and the palate leads one to regard Neanderthal man as specially adapted to live on a rough vegetable diet, yet split human bones were found with other Neanderthal bones and teeth. With an advancing glacial age and the consequent disappearance of vegetation, men would be finally driven into united internecine warfare to obtain food. Or again, he holds, Neanderthal man might have been wiped out by swarms of a less advanced, but more military, race of cannibals.

NEANDERTHAL MAN.

The earliest discovered skull of a Neanderthaloid is to be seen in the Royal College of Surgeons, in London. It was found in 1848, in a quarry on the north face of the Rock of Gibraltar. A second skull came to light in 1856 in the Valley of the Neanderthal, near Dusseldorf. At the place was probably a complete skeleton, but workmen clearing out a grotto, scattered the bones. Nearby, in a similar cave, were found bones of the cave bear and rhinoceros. After careful study of the remains, D. Schaaffhausen, in 1858, published his memoir, holding that the skull belonged to a man of primitive type, differing entirely from recent man. Virchow and others, held that the skull represented nothing but an abnormal type of man, and the battle raged for a while. Sir John Lubbock, in his "Prehistoric Times," (page 338), repudiates the suggestion made that the Neanderthal skull may have been the skull of an idiot, saying, "there is not, how-

ever, sufficient reason for this hypothesis; and though the shape of the skull is so remarkable, the brain appears to have been of considerable size, and, indeed, is estimated by Professor Huxley at about seventy-five cubic inches, which is the average capacity of the Polynesian and Hottentot skulls. It must, however, be admitted that though the antiquity of this skull is no doubt great, there is no proof that it belonged to the extinct Mammalia. Moreover, as Dr. Busk pointed out, (Natural History Review, 1861, p. 172) and as Dr. Barnard Davis maintains, 'we have yet to determine whether the conformation in question be merely an individual peculiarity or a typical character.'"

And again . . . "as regards the Engis skull, there seems no reason to doubt that it really belonged to a man who was contemporaneous with the mammoth, the cave bear, and other extinct mammalia; yet it is a perfectly well developed skull, so that, as Professor Huxley has well pointed out, 'the first traces of the primordial stock whence man has proceeded need no longer be sought, by those who entertain any form of the doctrine of progressive development, in the newest tertiaries; but that they may be looked for in an epoch more distant from the age of the *Elephas primigenius* than that is from us.'"

In connection with this, I strongly urge you, if interested, to read Huxley's chapter on Some Fossil Remains of Man, which you will find in his book, "Man's Place in Nature" published by Appleton and Co., of New York, in 1898. It contains an exhaustive examination of both the

Engis and the Neanderthal finds, and there are quoted long passages from Professor Schmerling as regards the first, and from D. Schaaffhausen in regard to the Neanderthal Cranium. The limits of this booklet, which after all, can be but a guide, or at least, an invitation to further study, naturally prohibits extensive quotations. But Huxley's closing words (page 207) are very valuable:

"The fossil remains of Man hitherto discovered do not seem to me to take us appreciably nearer to that lower pithecoid form by the modification of which he has, probably, become what he is. And considering what is now known of the most ancient races of man; seeing that they fashioned flint axes and flint knives and bone skewers, of much the same pattern as those fabricated by the lowest savages at the present day, and that we have every reason to believe the habits and modes of living of such people to have remained the same from the time of the Mammoth and the tichorhine Rhinoceros till now, I do not know that this result is other than might be expected.

"Where then shall we look for primitive man? Was the oldest **Homosapiens** pliocene or miocene, or yet more ancient? In still older strata do the fossilized bones of an ape more anthropoid, or a Man more pithecoid than any yet known await the researches of some unborn paleontologist?

"Time will show. But, in the meantime, if any form of the doctrine of progressive development is correct, we must extend by long epochs the most liberal estimate that has yet been made of the antiquity of Man."

However, other remains were discovered, and, presently, it began to be generally accepted that they were vestiges of a widely distributed race. Associated with the Neanderthal remains, and in the same stratum, were flint im-

plements and fragments indentified as belonging to the woolly mammoth, woolly rhinoceros, the cave bear, the reindeer and the cave hyena. In the course of time, came a whole series of discoveries, and, presently, it became possible not only to finally determine the skeletal characteristics, but the very probable size and proportions of the brain. We form a picture of a short, stocky fellow with heavy, overhanging brows and a retreating forehead. The space between the eyes is wide, and there is a broad, flattened nose. The head would be very large in proportion to the body, according to our notions. The shortness of the arm indicated a being far removed from tree dwellers, and the shortness of the shin bone told of a being both clumsy, and slow. The chest was massive, the ribs thick. On the authority of M. Boule, (L'homme fossile de La Chapelle aux Saints, 1913) we accept the Neanderthal man as having the knee habitually bent, and the thumb awkward in its motions. There would be also a tendency to squat.

The Neanderthal man was a mighty hunter, and a cave dweller. By what means he killed his game, we cannot determine. His tools seem to have been flints, and the mammoth and the woolly rhinoceros were tough skinned beasts. Yet, somehow, he killed and transported to his cave parts of the animal, splitting the bones for the marrow. There must have been weeks and months of blinding snow, when to live in the open was impossible, so that it was necessary to store his meat, and, not only that, but to defend it from the attacks of animals.

such as the cave bear. That there were fierce fights in those caves is undoubted. In one cave on the upper Saone, more than eight hundred skeletons of the cave bear were found.

THE HEIDELBURG MAN.

It seems fairly safe to assign for the Heidelburg man a period about 300,000 years ago, and during the long warm stage between the second and the third Glacial period. Two authorities, O. Schoenensack and J. Geikie, (The Antiquity of Man in Europe, 1914) give him and his predecessors a far greater antiquity, placing him as far back as the First Interglacial Stage. However, accepting the more conservative idea, we find him living in a warm period, sharing his world with the ancient elephant, the primitive bison, the lion, the wild cat, the wild boar, the broad faced moose and the beaver. The man of Heidelburg would appear to have been more primitive, more powerful, more ape-like than his successor, the Neanderthal man, but there is a general concensus of opinion that he is in the direct line from ape-like ancestor to human. A true missing link indeed.

Of his life, nothing definite can be said. He used flints, and, probably, chipped them with stone hammers from other flints. As for the smaller arrow heads, I am inclined to believe that in great measure, he shaped them with his teeth. In Tierra del Fuego, some thirty years ago, I watched the Ooan Indians, who closely approximated primitive man in their habits of life, and saw that having found a flint flake

having the shape and size of an arrow head, they would shape it rapidly with their canine teeth, by chipping off the thin edges.

In connection with the theory advanced that primitive man to a great extent used his teeth as tools, and so made the smaller flints, under date of April 17th, 1922, I received a letter from the Assistant Curator of the American Museum of Natural History, which reads in part:

"Professor Osborn has asked me to reply to your letter of recent date regarding the flint working processes of the Tierra del Fuegian tribes.

"Chipping flint by means of the teeth is a very unusual, though not an entirely unheard of procedure. W. H. Holmes, in his recent publication on stone working processes reviews all the commoner methods described, from John Smith's day down to my own recent observations on a California Indian, but he fails to mention any such procedure as you describe.

"Nevertheless, Castaneda's report on the Coronado Expedition at least suggests that stone knives were resharpened by use of the teeth, and I have been told that something similar is stated in the report on the Lewis and Clarke expedition. However, I should doubt the practicability of the method, unless the flake to be shaped is at least moderately thin and delicate. That chips can be moved in this manner I know from personal experimentation."

THE TRINIL RACE.

The Trinil race, the ancestors of man,—but let us go on tip-toe now. There is a vast literature on the subject, and at any time some fresh discovery may throw further light on the subject. It was due to the discovery of a Dutch army surgeon in 1891 that the type of *Pithe-*

canthropus erectus was known. In Central Java, near Trinil, he discovered mammal bones and a single upper molar tooth, which, at first, he took to be that of some new species of ape. Careful search presently revealed the top of a skull, and, later, a second molar tooth and a left thigh bone were brought to light. Says Dubois, "this fossil creature had the same upright posture as man and likewise walked on two legs. . . From this it necessarily follows that the creature had the free use of the upper extremities. . . and that these last were no doubt already far advanced in that line of differentiation which developed them in mankind into tools and organs of touch. From a study of the femur and skull it follows with certainty that this fossil cannot be classed as simian. Pithecanthropus erectus is the transition from between man and the anthropoids which the laws of evolution teach us have existed. He is the ancestor of man."

A most recent discovery of human fossil remains was made last year in a natural cave in Northern Rhodesia. According to an article in the *Atlantic Monthly* of May, 1922, and illustrations in the *London Illustrated News*, we have here an evidence of a man more definitely primitive and brutal than even the man of Java, (Trinil Race). The nose would seem to have been merged in the face thus recalling the gorilla. Yet, in spite of this it has distinctly human features. In some respects there is the suggestion of a kind of inferior Neanderthal man. The leg bones that have been dis-

covered amply prove that the Rhodesian man walked erect.

It is too early to speculate over much just now, and we must wait for further details from those who have the remains now under investigation.

WHY ARE HUMAN REMAINS SCARCE?

A word on the extreme rarity of human fossil remains is in place, for, considering the countless of millions that have died, it may seem suspicious that human finds have been so extremely rare. Indeed, books have been written tending to cast ridicule upon the whole theory of pre-historic man and his existence during the ice age, the writers holding that this skull, that skull, and the other, are but comparatively recent remains that have fallen into lower strata. But it pays to remember that of man's bones, light and small as they were, hyenas and vultures would make small work. Then, as Clodd pointed out, there is the dissolving action of certain acids, especially in peat, to be taken into account. Bear also in mind the carrying off of bodies by rivers into the sea, and, not by any means least, the disposition of the human being in all ages, apparently, to dispose of his dead in some way, often by burning. Again, as Clodd says in his "Primitive Man," "The larger and more solid bones of the elephant and the rhinoceros, the ox, horse and stag, remain, but every vestige of the smaller bones has perished. Not only were Paleolithic men widely scattered; their numbers relative to other animals were small. Bas-

ing these on estimates of the proportions among hunting tribes, the figures would be about 750 to 1; and allowing for the length of man's life as 4 to 1, it follows that about three thousand skeletons of different animals of the chase would be left for one human skeleton." As bearing on the subject, it is well to adduce the draining of Haarlem Lake fifty years ago. A large population had lived on its banks for centuries, ships had been wrecked in it, naval battles had been fought on it, yet the engineers found no human bones whatever.

LUBBOCK'S CALCULATION.

Sir John Lubbock interests himself in the matter of the scarcity of human bones in his essay on "River Drift Gravel Beds," to be found in Chapter XI of his "Pre-historic Times." I quote the salient passage.

"The almost entire absence of human bones, which has appeared to some so inexplicable as to throw a doubt on the whole question, is, on consideration, less extraordinary than it might as first sight appear to be. If, for instance, we turn to other remains of human settlements, we shall find a repetition of the same phenomenon. Thus, in the Dutch shell-mounds, where worked flints are by far more plentiful than in the St. Acheul gravel, human bones are of the greatest rarity, only one piece in fact having ever been found. At that period, as in the Drift age, mankind lived by hunting and fishing, and could not, therefore, be very numerous. In the era, however, of the Swiss Lake habitations, the case was different. M. Tryon estimates the population of the 'Pfahlbauten' during the Stone Age at about 32,000: in the Bronze era, 42,000. On these calculations, indeed, even their ingenious author would not probably place much reliance: still, the number of the Lake villages already

known is very considerable; in four of the Swiss lakes only, more than seventy have been discovered, and some of them were of great extent; Wangen, for instance, being, according to M. Lohle, supported on more than 50,000 piles. Yet, if we exclude a few bones of children, human remains have been obtained from these settlements in six cases only. The number of flint implements obtained hitherto from the drift of the Somme valley probably does not exceed 5,000; the settlement at Concise alone has supplied about 24,000, and yet has not produced a single human skelton. Probably this absence of bones is in part attributable to the habit of burying or burning. Still, so far as the drift of the St. Acheul is concerned, the difficulty will altogether disappear, if we remember that **no trace has ever yet been found of any animal as small as a man.** Even of the elephant and rhinoceros, the ox, horse and stag, only the larger and more solid bones remain; every vestige of the smaller ones has perished. No one supposes that this scanty list fairly represents the mammalian fauna of this time and place. When we find at St. Achuel the remains of the wolf, boar, roedeer, badger, and other animals which existed during the drift period, then, and not till then, we may perhaps begin to wonder at the entire absence of human skeletons.

"We must also remember that when man lived on the product of the chase there must have been a very large number of wild animals to each hunter. Among the Laplanders, 100 reindeer is the smallest number on which a man can subsist, and no one is considered rich who does not possess at least from 300 to 500. But these are domesticated, and a large supply of nourishment is derived from their milk. In the case of wild animals we may safely assume that a much larger number would be necessary."

At which point, Sir John Lubbock goes into a calculation intended to set forth the proportion of men to other animals, making his esti-

mate on the number of skins received by the Hudson Bay Company in 1866, and finding as a final result that there are 108,000,000 animals to 139,000 Indians, or about 750 animals to each man. In conclusion he adds:

"Lastly, it may be observed that man is less likely to be drowned by sudden river floods than is the case with other mammalia, and, on the whole, therefore, it is natural that the bones of animals would be far more common in these gravels than those of man."

PROOF BY THE ROCKS.

I am writing this in a town in Ohio, just north of Columbus, and have been, very recently, to Southern Ohio, in Brown County. Here, gathered and piled in pyramid form in a corner of a lawn, are some twenty granite rocks roughly rounded. Again, down in Brown County, where there is a limestone formation, in Straight Creek, and in other rivers, I saw similar granite balls. That these were not carried there by human agency is very certain. No one would want to go to that trouble. That they did not belong to the geological formation of the country in which they lie is also certain. They have, then, been moved to their present position by non-human agency. Or again, here and there, in central Ohio, in Pennsylvania, in County Kerry, Ireland, may be seen huge granite rocks which do not belong to their present location and to move which would take labor and machinery which man has never had to spare.

Searching further, one finds huge flat rocks, scratched and scarred. The problem to account

for the scratches, the rounded granite stones also having been seen, would be very much like the problem confronting a mother who saw her polished table mysteriously scratched, found on the floor a handful of marbles, and, on the floor beside them, a chess board. She would rapidly deduce, in addition, the activity of a thoughtless child. Then all would be accounted for. So, consider the glaciated, scratched rock as the table, the rounded rocks as the marbles, and a mighty glacier, slowly moving, as the chess board moved by the childish hands. The trained eye of the geologist can go further, can see still more. It can follow the course of the glacier, the grinding work it has done, the Laurentian range it has broken up, the pieces of which, in the form of giant marbles, litter every farm from Lake Superior to the Ohio River. For, it is possible to point out the actual districts from which the rounded stones have been torn.

Let me, at this point, recommend the reading of Huxley's "Darwiniana Essays" to those who have been interested enough to follow thus far. For, I cannot sufficiently reiterate that this booklet cannot pretend to be a handbook of complete instruction. Neither Mr. Haldeman-Julius, the editor, nor I, the writer, propose to sail under false colors. His idea is to interest the intelligent to such an extent that they may pick up a key to open a door of real knowledge. For my part, I am by no means a specialist in these matters. In years past, I had the extreme good fortune to hear not only T. H. Huxley lecture, but also Sir John

Lubbock and Sir Robert Ball, and so became interested enough to follow the paths they had indicated. Also, I gathered a considerable library on the subject. But that is a digression, though still to the point in a way. For, when it is remembered that on any one subject here dealt with, ancient man, for example, or the astronomical aspect of the Ice Age, or the record as written in the layers of stone which form the earth's crust, hundreds of books have been written, and yet much remains to be said, it will be seen, I hope, that this booklet can be nothing more than the slightest of guides.

Huxley, then, has six lectures to workingmen which were delivered in 1863, "On Our Knowledge of the Causes of the Phenomena of Organic Nature," and those you should read. Especially illuminating is that portion in the second lecture in which he tells of the "record composed of mud," to use his own words. For, says he, "in Nature, there is nothing mean and unworthy of attention; there is nothing ridiculous or contemptible in any of her works; and this inquiry, you will soon see, I hope, takes us to the very root and foundations of our subject." Then, too, he uses illuminating diagrams which are impossible here, but certainly necessary for a complete understanding.

EVIDENCE FOR AN ICE AGE.

The evidences then for the existence of an Ice Age may be lightly summed up as, (1) the existence of isolated boulders belonging to a distant location which lie scattered over the

country; (2) the remarkable way in which hills and valleys in glaciated regions have been shaped; and, (3) the scratched rocks and layers of boulder clay which have been ground under the advancing ice mass.

In our own time, at the North Pole, and encircling the Artic regions we have a condition exactly similar to that which existed when huge glaciers submerged Canada and the northern states and occupied the basins of the great lakes. (See Wright's Ice Age in North America.) There is, of course, intense glaciation also at the South Pole.

But there was a time when the ice caps at the poles were not confined within their present bounds, but crept on, down to what are now temperate regions, and now the life that abounded crept further south, retreating before the oncoming cold. The progress was intermittent—rapid in winters, slower in summer, but, nevertheless, there was, for thousands of years a steady advancement, until the ice lay thousands of feet thick. Then, from causes that shall be presently shown, there was an amelioration, and the ice withdrew again, as slowly as it had advanced, so that in time the normal condition held.

Yet it is not right to entertain the idea that the polar regions have always been a center of cold. The investigations of polar explorers have shown that a luxuriant vegetation once clothed the far north. As Sir Robert Ball put it, "I would have you think of our earth, or more accurately of one hemisphere of the earth, as robed from time to time in three different

garbs. There is, first, the garb of extreme glaciation which prevails during an ice age; the second is one when what may be described as a perennial summer prevails in the land, and extends even to the vicinity of the pole itself; this we may call the genial garb. There is, thirdly, an intermediate garb, where the climate has neither the severity of the Ice Age nor the mildness of the Genial Age. This intermediate state may be illustrated by the condition in which we find our earth today, and in which it has been during the centuries known to human history."

BALL'S THEORY OF THE CAUSE OF THE ICE AGE.

Many causes have been advanced. To me, the most satisfactory is that given by Sir Robert Ball, Astronomer Royal of Ireland. You will find in the Modern Science Series published by Appleton & Co., in 1897, a book bearing the title, "The Cause of An Ice Age." What follows is a summary of Chapters IV and V of that work.

If the earth was a solitary planet revolving about the sun, there would be no change whatever in its orbit, therefore no explanation of an Ice Age, nor, indeed, any Ice Age to explain. But the earth is not alone in its revolution about the sun. There are planets whose orbits are lesser, such as Mercury and Venus, and those whose orbits are larger, such as Mars, Jupiter, Saturn, Uranus and Neptune. There are, in addition, some hundreds of planets much smaller than the earth, also parts of the solar system. Now, as has been shown by New-

ton, every body attracts every other body, and, not only is there an attraction between sun and planet, but also between planet and sister planet. Jupiter is attracted by the sun, but also, in turn, attracts the earth, and the intensity of the mutual attraction between every pair of planets is "measured by the product of the masses of the two planets, divided by the space of their distance apart."

It can be easily seen then that to determine the motions in the solar system, is a complicated problem. The path of each planet, while determined chiefly by the attraction of the sun, is influenced by each and every other planet in greater or less degree. In other words, according to the distance of fellow planets in the solar system, the earth, as well as all other bodies in the solar system, moves along a curve, not equal, but of the utmost complexity. The variation is known as "planetary perturbations" and offers one of the most difficult problems in the whole range of science. And, it might be mentioned, that when the doctrine of perturbations first received attention, there were timid folk, untrusting people, who feared lest the irregularities of the earth's orbit should grow to such an extent that total disorganization might ensue. For instance, it was thought that there was a possibility that a gathering of planets at the furthest distance from the sun, might draw the earth altogether from the benefit of the sun's warmth, or, that pulling in another way, the earth might be brought into too close proximity with the sun so that life on the earth might become impossible because of extreme

heat. In time, better sense prevailed, and it became established that the nearly circular orbits of the planets can never depart more than a certain extent from that form. To quote Ball, " . . . the dimensions of those orbits as measured by the longest diameters remain unalterably constant, and the situations of the planes of the orbits must always remain in the vicinity of their present situations."

Bearing in mind, then, that planets do exercise an attraction, and that this attraction may have the effect of slightly, and temporarily, changing the earth's orbit, it becomes interesting to consider the effect of the force. Ball tells us in his chapter on the Perturbations of the Earth's Orbit that he has calculated the magnitude of the force which the planet Venus exercises on the earth, and puts it at 130,000,000,000,000 tons. This, however, is but 27/1000's part of the sun's attraction.

Next in importance to the force exercised by Venus, is that due to the attraction of Jupiter, which, though of far greater volume, its mass being indeed a thousand times that of Venus, has only one-half the disturbing force of the lesser planet, because of its greater distance away. Even the smallest planet exercises a force, which, measured in earth tons, is incredible at first reading. Take for instance the smallest of the planets, one which is the merest speck of light visible in a powerful telescope, the planet Eudora. It is only a few miles in diameter, yet, as Sir Robert Ball computes, the cables of the Brooklyn Bridge would snap like pack thread if exposed for a moment to

a strain equal to that exerted upon the earth by Eudora. Then, too, there is the host of stars outside the solar system, but these, because of their immense distance, the disturbing force varying according to the inverse cube of the distance have but little effect. So, minor perturbations may be neglected and our attention fixed upon the influence of Jupiter and Venus, for these are the planets largely responsible for major changes in the earth's orbit and, therefore, for the production of the Ice Age.

RHYTHM PRODUCES AN ICE AGE.

In short, Ice Ages are produced because of that rhythm which pervades all things. The circuits of the planets stretch and then recede. Eclipses elongate and flatten again to the semblance of circles. The poles slowly nod once every many thousand years. There is a waxing and a waning in the ellipticity of the earth's orbit, but, remember, even when the orbit has departed to the utmost extent from a circle, it is still not to be regarded as a long ellipse.

Slight as the change is, it is sufficient to account for such a stupendous phenomenon as an Ice Age. With great care, and in a manner in which it is impossible to reproduce here, as diagrams are required, Ball shows most clearly that the heat received *on the whole earth* from vernal to autumnal equinox equals that received *on the whole earth* from autumnal equinox. Then: "it is obvious that summer in one hemisphere is winter in the other; therefore, when we speak of the heat received during summer, we must, of course, have one particular hemis-

phere in mind. Think then of the Northern Hemisphere. It receives a certain quantity of heat during the passage from the vernal equinox to the autumnal equinox—that is, during the summer in the Northern Hemisphere. It also receives a certain quantity of heat between the autumnal equinox and the next vernal equinox —that is, during the winter in the Northern Hemisphere. But these quantities are NOT equal. Here then, is the cardinal feature of the book.

"*Of the total amount of heat received from the sun on a hemisphere of the earth in the course of a year, 63 per cent is received during the summer and 37 per cent during the winter.*"

Ball is very emphatic about that. It is a fact that must be thoroughly grasped, and if not thoroughly grasped, it is of no use to proceed further. It is like two and two are four. There must be no mistake about their significance. He says, very plainly, "This theory (the astronomical theory of the Ice Age) will be entirely misunderstood unless the facts signified by these numbers are borne in mind." And further, "No one can discuss the astronomical theory of the Ice Age unless the figures 63 and 37 form part of his consciousness and the refrain of his every argument."

There follows then the argument that goes to show that about every 21,000 years, the line of equinoxes is so placed with reference to the elliptic path of the earth that the difference in duration between the two seasons attains a maximum, that maximum depending, of course, upon the eccentricity of the orbit at the time.

Then, touching on the greatest eccentricity that the earth's orbit can assume under the disturbances arising from the influences of other planets, he shows, that when all circumstances combine to accentuate as much as possible the difference in the lengths of the seasons, one of them may be 199 days long, and the other 166, making the yearly total of 365 days.

BALL'S CARDINAL FEATURE.

At this point one must not attempt to focus Professor Ball is very explicit and it is best to quote.

'I must here recall the fundamental theorum to which I have so often referred, which states that 63 per cent of the total sun heat of the year on either hemisphere is received during summer, and only 37 per cent is left with which to eke out the winter. Fortunately for the simplicity of our calculation, we have seen that these figures are independent both of the eccentricity of the orbit and of the position of the line of equinoxes. We are therefore entitled to apply these figures to those critical epochs in past time when, by a confluence of causes, the maximum difference in duration of seasons had been reached. There was therefore an epoch, or doubtless more than one, when the seasons were 199 and 166 days, and when the shares of sun heat received on each hemisphere during these seasons were 63 and 37 respectively. We may express the matter a little more clearly by describing more particularly the case of the Northern Hemisphere. There were epochs when the Northern Hemisphere had a summer of 199 days and a winter of 166 days: there were also epochs when in the same hemisphere the winter endured for the long period of 199 days while the summer only lasted 166. In each case, however, the figures 63 and 37 are to represent the proportional qualities of heat which that hemisphere received in summer and

winter respectively. We have to suppose two cases, that in which the long season was the summer and the short season the winter, and that in which the long season is the winter and the short season the summer. The climatic conditions of the two cases are profoundly different. In the first place the long summer and the brief winter would certainly afford a much more uniform distribution of the sun's benefits than would be found in the opposite case. Seeing that 63 measures of heat come in summer and 37 in winter, it would seem equitable that the 63 measures should extend over the long season of 199 days, leaving the 37 measures to do the best they could for the brief winter of 166 days. But while the Northern Hemisphere was enjoying the beneficent climate which these figures indicate, the climatic condition of the Southern Hemisphere would be totally different. There, too, the seasons had the same lengths of 199 and 166 days respectively, but of course the summer in the Northern Hemisphere was the winter in the Southern; and consequently while the 63 measures of heat, which the Southern Hemisphere received, were all poured in during its brief summer of 166 days only, the remaining 37 were left to supply the protracted winter of 199 days."

In the volume there follow two diagrams, the one showing a condition in which there was a glacial northern hemisphere, the second with a genial northern hemisphere, a period of 10,500 years separating the two, in point of time.

Studying the problem given by Sir Robert Ball in the quoted passage, it will be seen that the extreme contrasts between the climates of the two hemispheres that have occasionally arisen can be expressed and easily grasped thus:

INTERGLACIAL PERIOD.
229 heat measures spread over 199 days.
136 heat measures spread over 166 days.

GLACIAL PERIODS.
229 heat measures spread over 166 days.
136 heat measures spread over 199 days.
The average daily receipt of sun heat is stated then as:

PRESENT TIME.
Mean daily sun heat in summer (186 days) 1.24
Mean daily sun heat in winter (179 days) .75

INTERGLACIAL.
Mean daily sun heat in summer (long) 1.16
Mean daily sun heat in winter (short) .81

GLACIAL.
Mean daily sun heat in summer (short) 1.38
Mean daily sun heat in winter (long) .68

Summing up we come to this. So long as the earth's orbit is nearly circular, there can be no extensive glaciation. Seasons must be as they are now. When, in the course of time, other planets are so disposed, which comes to pass at regular periods and after immense intervals of time, the earth's orbit passes from the nearly circular to the elliptic, and that form persists during a period sufficiently long to account for an Ice Age. This, though, is only the first condition. When the line of equinoxes happens to be perpendicular to the axis major of the ellipse, we have a second necessary condition for the establishment of an Ice Age. Again quoting Sir Robert Ball, (page 105): "Nor is there anything arbitrary in the assumption that the adaptation of the line of equinoxes to this critical position shall take place once, or more than once, during the continuance of a high degree of eccentricity in the

orbit. The changes in the shape of the orbit require enormously longer periods of time than those which suffice for the revolution of the equinoxes. The changes in the eccentricity proceed with such extreme slowness that the ages during which the eccentricity remains in the vicinity of its maximum value are long enough to admit of more than a single revolution of the line of equinoxes. Indeed, it would seem to have happened not infrequently that several successive revolutions of the line of equinoxes with respect to the major axis have had time for their completion before the eccentricity had sufficiently declined to render glaciation impossible."

To clarify, Ball suggests that it be imagined that the Northern Hemisphere is so placed that it has a summer of 166 days and a winter of 199 days. Obviously, our own half of the world will have a brief but very hot summer, with the sun at its least possible distance from the earth, and a long winter, very cold, with the earth and sun widely separated as possible. During the winter there will be an accumulation of ice and snow which the brief summer will not be able to melt. Winter will gain on summer. The ice cap will grow, and extend far beyond its ordinary limits. Meanwhile, the Southern Hemisphere will enjoy a far different climatic condition. A moment's thought will reveal the fact that in the south then, the winter would be mild and the summer long, but the sun's heat would be mitigated, because the earth and sun would be as far apart as possible.

NO HEAT, NO ICE.

But, as Ball clearly points out, it would be misleading to suppose the extreme cold alone would be the cause of an Ice Age. Heat is also necessary. For snow requires clouds, and clouds bespeak evaporation. Heat indeed is an important factor in the formation of an ice sheet. As Professor Tyndall has shown, the heat which would be required to raise enough water to the clouds, would be sufficient to melt a stream of cast iron five times the weight of the gracier itself.

"Cold," says Tyndall, (Heat Considered as a Mode of Motion, p. 192) "will not produce glaciers. You may have the bitterest northeast winds here in London without a single flake of snow. Cold must have the fitting object to operate upon, and this object—the aqueous vapor of the air—is the direct product of heat. Let me put this glacier question in another form; the latent heat of aqueous vapor, at the temperature of its production in the tropics, is about a thousand degrees Fahrenheit, for the latent heat arguments as to the temperature of evaporation descends. A pound of water thus evaporated at the equator, has absorbed one thousand times the quantity of heat which would raise the liquid one degree in temperature. . . It is perfectly manifest that by weakening the sun's action, either through a defect of emission, or by the steeping of the entire solar system in space of a low temperature, we should be cutting off the glaciers at their source."

But it would be unwise to pass on without glancing briefly at a theory or two adduced by other scientists to account for the Ice Age, for, while that of Sir Robert Ball has satisfied me, it has been by no means unanimously received.

First, we pass with a mere nod of recognition, as it were, the very latest theory of Professor Wegener, which is so very recent, that at the moment of writing this, (April 5th, 1922) it has not been noticed in American newspapers. The German scientist holds that all the vast earth changes of which glacial periods are parts, are due to actual movements in latitude and longitude of the great continents. Continents, he says, rest unstable on denser material across which they move towards the west and varying their distance from the poles, which at various periods have changed their positions relative to different land regions.

WEGENER'S THEORY.

Professor Wegener will have to produce more evidence than he has given before he convinces geologists of the soundness of his theory. To be sure, there is on the planet Jupiter a present movement much like that which he postulates for the earth. Certain well defined physical features on that planet are moving independently of its axial rotation. The French astronomer, Cammille Flammarion, has watched and measured those movements for several years and has compared the movement to what it might be were Austraia to wander about the earth. Still, Jupiter is not the earth

SIMROTH'S IDEA.

About twelve years ago Dr. H. Simroth, Professor of Zoology at Leipzig University, produced his essay "Die Penrulations Theorie" in which he explained the observed facts of the change in temperature and the development and habitat of men and animals through long periods of time, by suggesting a pendulum like swing of the earth's poles from one hemisphere to another along the meridian 10 degrees east of Greenwich. He put forth a mass of geological facts, such as the evidence of a warm period in Greenland and the arctic in support of his theory, but failed to convince the world. Of course, that the earth's axis is not immutably fixed has been well demonstrated in the past thirty years. It most certainly performs a spiral-like movement around its theoretical position, but the variation is very small—at Greenwich the maximum is less than 50 feet, so quite negligible compared with the magnitude demanded by the theories of Wegener and Simroth.

ADHEMAR'S VIEW.

But of weightier theories, Sir John Lubbock in his "Pre-historic Times" gave prominence to that of M. Adhemar, who, in his "Revolutions de la Mer" suggested a mode for accounting for the cold of the glacial epoch, and not only that, but would give us means of calculating its antiquity. His carefully worked out table I shall put at the end of this booklet, and from it you will see that the glacial epoch is assigned a

period which may seem to approximate both that favored by Ball and Osborn. I summarize from the Lubbock account, pages 405 to 410.

If the plane of the equator coincided with that of the liptic, that is, with the earth's orbit, then the length of day would equal the length of night at all times. But because of the obliquity of the eliptic, only two days in the year, March 20th and September 23rd are of equal length. So our year is divided into four periods and "winter" begins Dec. 22nd, the shortest day of the year, and spring begins March 20th, night and day being then equal. "Spring" lasts from March 20th to June 21st when the days commence to lengthen and the nights to shorten. But from June 21st, the first day of summer, the days shorten until September 23rd when night and day are again of equal length. "Fall" commences September 23rd and the days from then shorten until Dec. 22nd.

In our time, the northern hemisphere has in each year seven days more of spring and of summer than of fall or winter, and, conversely, south of the equator conditions are reversed. This inequality of the seasons is due to the rapidity with which the earth moves when nearest the sun (perihelion).

But the dates of the perihelion and the spring equinoxes have not always been the same as at present. A slow movement is always taking place and the spring equinox gradually shifts forward, and perihelion advances. The interval so diminishing, they will be some day coincident, and, in about 21,000 years from now again

as far apart as at present. As can be seen, the longest and the shortest days and the autumnal equinox change in the same manner as the spring equinox, wherefore the northern and the southern hemispheres alternately enjoy a preponderance of summer. Up to the year 1248 the duration of summer was increasing, for in that year the first day of winter corresponded with the passage of the earth into perihelion.

M. Adhemar points out that our northern hemisphere has 4,464 hours of day in the year and 4,296 hours of night, while the southern hemisphere enjoys only 4,296 hours of day with 4,464 hours of night. Admitting then that the southern hemisphere receives as much heat from the sun in its lesser number of day hours as we do in the 4,464 hours, he holds that it will retain less because it will have 168 hours more of night in which heat radiation will be going on. This condition then must be considered as cumulative. So, M. Adhemer holds, the immense mass of ice, slowly increasing about the south pole must affect the center of gravity of the earth, and, therefore, attract the ocean southward. In similar manner he accounts for the accumulation of land about the northern pole. A glance at polar maps will show the difference.

According to the theory then, 11,120 years ago, or 10,500 years prior to 1248, when the northern glacier was at its coldest and maximum, the southern was at its minimum, and the preponderance of water would have been in

the northern hemisphere. So, as the weight of ice exists in either the north, or the south polar region, there would be a transfer of the center of gravity, and, consequently a rush of water alternately from north to south or the reverse, every 10,000 years.

In support of his theory, M. Adhemar points out that the southern ice has considerably retreated since the time of Captain Cook and also points to the increase of the Alpine glaciers and of the Greenland ice. He considers that the last epoch of greatest cold was 11,120 years ago since when, and up to the year 1248, the climate of the northern hemisphere gradually improved. Since then, according to his theory, it must have slowly deteriorated. Sir Charles Lyell in his Principles of Geology, 1867, vol. 1, p. 278, combats this idea, holding that the change, "which could hardly produce more than a difference of half a degree Fahrenheit between the cold of the present winter and that of 1248, would be appreciable."

THE DURATION OF AN ICE AGE.

As to the time of the climax of an Ice Age in one hemisphere to the time when a climax has been reached in the other, Ball sets the interval as about 21,000 years. He says, "If the earth's orbit retained a constant position in its plane, then we could assert with every confidence that the interval from one phase of an Ice Age to the return of the same phase in the same hemisphere would be the period of 25.694 years. However, the earth's orbit does not always remain in the same situation, for the attractions of the

planets cause the elements of the orbit of the earth to be more or less variable. The position of the axis of the earth's orbit forms no exception to this law; it has a slow motion in the plane of the orbit, which can be determined with sufficient accuracy. Its effects become blended with those of the precession of the equinoxes, thus producing a new movement of the axis relatively to the equinoxes of 1 degree 42 minutes and 6 seconds every century. Thus we obtain for the period of the changes a term of about 21,000 years. It should be distinctly understood that neither in this place nor in any other do I make any attempt to estimate either the date of the last glacial epoch that desolated the earth, or the date at which the next may be expected. It is true that such estimates have been formed, but they depend upon formulae which can hardly be relied upon for such an extreme application as is demanded of them. What I now desire to convey is, that when, after the lapse of gigantic periods, a series of conditions suitable to glaciation have supervened, then, for so long as those conditions remain fulfilled, the ice cap oscillates between one hemisphere and the other with the interval of 21,000 years that we have just determined."

Thus, as will be seen, there is a wide difference of opinion between scientists as to duration. The Ball astronomical theory would tend to shorten the duration of man on the earth, as also, the interglacial periods. In other words, the geologist and the astronomer would seem to have much to settle. Still, there is a

variety of opinion shown among geologists themselves, and, of course, there necessarily must be until new discoveries cast new light.

Examine the table that next follows, which shows the duration of the ice age according to the opinions of eight authorities:

		Years
1863	Charles Lyell, "Principles of Geology"	800,000
1874	James D. Dana, "Manual of Geology"	720,000
1893	Chas. D. Walcott, "Geologic Time"	400,000
1893	W. D. Upham, "Estimates of Geologic Time"	100,000
1894	A. Heim, "Ueber das absolute Alter"	100,000
1900	W. J. Sollas, "Evolutional Geology"	400,000
1909	Z. Penck, "Die Alpen im Eiszeitalter"	520,000 to 840,000
1914	Jas. Geikie, "Antiquity of Man in Europe" (as quoted by Osborn)	620,000

Sir C. Lyell, ("Antiquity of Man," pp. 282, 285), attempted to form an estimate of the duration of the glacial epoch, on the assumption that the different movements of the elevation and depression proceeded at an average rate of 2½ feet in a century. As the simplest "series of changes in physical geography which can possibly account for the phenomena of the glacial period," he gives the following:

"First a continental period, towards the close of which the forest of Cromer flourished: when the land was at least 500 feet above its present level, perhaps much higher, and its extent much greater than that given in the map, fig. 41." In this map the British Isles, including the Hebrides, Orkneys and Shetlands, are connected with one another and with the continent, the whole German ocean being laid dry.

"Secondly, a period of submergence, by which

the land north of the Thames and Bristol Channel, and that of Ireland, was gradually reduced to an archipelago and finally to a general prevalence of sea, only the tops of the mountains being left above water. This was the period of great submergence and of floating ice, when the Scandinavian flora, which overspread the lower grounds during the first continental period, may have obtained exclusive possession on the only lands not covered with perpetual snow.

"Thirdly, a second continental period, when the bed of glacial sea, with its marine shells and erratic blocks, was laid dry, and when the quantity of land equaled that of the first period."

Considering this, Sir John Lubbock in his "Pre-Historic Times," p. 417, says:

"It is evident that such changes as these would require a great lapse of time. Sir Charles Lyell admits that the average change of 2½ feet in a century is a purely arbitrary and conjectural rate, and that there are cases in which a change of as much as 6 feet a century appears to have taken place: still it is in his opinion probable that the rate assumed in a century, is, if anything, above the average: and in this I believe most geologists would be disposed to agree with him. On this hypothesis the submergence of Wales, to the extent of 1,400 feet, would require 56,000 years; but 'taking Prof. Ramsay's estimate of 800 feet more, that elevation being required for the disposition of some of the stratified drift, we must demand an additional period of 32,000 years, amounting in all to 88,000; and the same time would be required for re-elevation of the tract to its present height. But if the land rose in the second continental period no more than 600 feet above the present level, this . . . would have taken another 24,000 years; the whole of the grand oscillation, comprising the submergence, having taken, in round numbers, 224,000 years for its completion; and this, even if there were no pause or stationary period, when the downward

movement ceased, and before it was converted into an upward one.'

"To the geologist, however, these figures, large as they are, will have no appearance of improbability. All the facts of geology tend to indicate an antiquity of which we are but beginning to form a dim idea. Take, for instance, one single formation—our well known chalk. This consists entirely of shells and fragments of shells deposited at the bottom of an ancient sea, far away from any continent. Such a progress as this must be very slow: probably we should be much above the mark if we were to assume a rate of deposition of ten inches in a century. Now the chalk is more than a thousand feet in thickness, and would have required therefore more than 120,000 years for its formation. The fossiliferous beds of Great Britain, as a whole, are more than 70 feet in thickness, and many which measure only a few inches, on the continent extend to strata of immense depth; while others of great importance elsewhere are wholly wanting in England, for it is evident that during all the different periods in which Great Britain has been dry land, strata have been forming (as is, for example, the case now) elsewhere, and not with us. Moreover we must remember that many of the strata now existing have been formed at the expense of older ones; thus all the flint-gravels in the southeast of England have been produced by the destruction of chalk. This again is a very slow process. It has been estimated that a cliff 500 feet high will be worn away at the rate of an inch in a century. This may seem a low rate, but we must bear in mind that along any line of coast there are comparatively few points which are suffering at one time, and that even on those, when a fall of cliff has taken place, the fragments serve as a protection to the coast until they have been gradually removed by the waves. The Wealden Valley is twenty-two miles in breadth, and on this data it has been calculated that the denudation of the Weald must have required more than 150,000,000 of years.

"There can be no doubt about the interest of these calculations, and thay have also the great merit of giving some definiteness to our ideas. We must not, however, attribute to them a value which has been distinctly disclaimed by their authors."

APPENDIX.

Table of eccentricity to illustrate the Adhemar theory.

Mammals of the Ice Age—the mammoth, the horse.

TABLE OF ECCENTRICITY

		Number of years before A.D. 1800	Eccentricity of Orbit	Difference of distance in millions of miles	Number of winter days in excess	Mean of hottest month in lat. of London	Mean of coldest month in lat. of London
		1,000,000	.0151	2¾	7.3	83 dgF	21 F.
D		950,000	.0157	9¼	25.1	109 dg	3
		900,000	.0102	1¼	4.9	80	23
	a	850,000	.0747	13⅕	36.4	126	7
	c	800,000	.0132	2¼	6.4	82 dg	22 dg
		750,000	.0175	10½	27.8	113 dg	0 dg 6
		700,000	.0220	4	10.2	87 dg	17
C	b	650,000	.0226	4	11	88 dg	16 dg
		600,000	.0417	7½	20.3	101 dg 9	7 dg 9
		550,000	.0166	3	8	84 dg	20 dg
		500,000	.0388	7	18.8	99 dg	9
		450,000	.0308	5½	15	94	13
		400,000	.0170	3	8.2	84	20
		350,000	.0195	3½	9.5	86	18
		300,000	.0424	7¾	20.6	102	7
		250,000	.0258	4½	12.5	90	15
B	a	210,000	.0575	10½	27.8	113	0 dg 7
	b	200,000	.0567	10¼	27.7	113	1 dg 9
		150,000	.0332	6	16.1	95 dg	12
		100,000	.0473	8½	23	105 dg	5 dg
		50,000	.0131	2¼	6.3	82 dg	22
			.0168	3	8.1	81 dg	20 dg

The above table shows the variations in the eccentricity of the earth's orbit for a million years before A.D. 1800, and some of the climatical effects of such variations.

Explanation of the Table.

Column 1—Division of a million years preceding 1800 into twenty equal parts.

Column 2—Computed by Mr. James Croll, by aid of Leverrier's formula, gives the eccentricity of the earth's orbit, in parts of a unit equal to the mean distance, or half the longer diameter of the ellipse.

Column 3—Which together with the three following columns, has been computed by Mr. John Carrick Moore, gives in millions of miles the difference between the greatest and the least distances of the earth from the sun, during the eccentricities given in Column 2.

Column 4—Gives the number of days by which winter, occurring in aphelion, is longer than the summer in perihelion.

Column 5—Gives the mean temperature of the hottest summer month in the latitude of London when the summer occurs in perihelion.

Column 6—Gives the mean temperature of the coldest winter month in the latitude of London when the winter occurs in aphelion.

As will be seen, there are four periods marked A. B. C. and D. in which there has been a large eccentricity, and, therefore, an extreme climate. According to Sir Charles Lyell, the periods marked A. and B.

Would not, I conceive, be sufficiently distant from our era to afford time for that series of glacial and post glacial events which we can prove to have happened since the epoch of the greatest cold. These events relate to changes in the level of the land in opposite directions, as well as the excavation of valleys and variations in the range and distribution of aquatic and terrestrial animals, all of which take place at so slow a rate that 200,000 years would not be sufficient to allow of the series of changes with which we are familiar. I agree, therefore, with Mr. Croll, that if the date of the most intense glacial cold can be arrived at by aid of a very large eccentricity, it would be a more probable conjecture to assign C than B as the period in question, in other words, to regard the glacial epoch as representing a period of 800,000 years ago."

". . . But when speculations on the long series of events which occurred in the glacial and post-glacial periods are indulged in, the imagination is apt to take alarm at the immensity of the time required to interpret the monument of these ages, all referable to the era of existing species. In order to abridge the number of centuries which would otherwise be indispensable, a disposition is shown by many to magnify the rate of change in pre-historic times by investing the causes which have modified the animate and the inanimate world with extraordinary and excessive energy. . . . We of the living generation, when called upon to make grants of thousands of centuries, in order to explain the events of what is called the modern period, shrink naturally at first from making what seems so lavish an expenditure of past times." (Sir Charles Lyell in his address to the British Association, 1864, page 21.)

ON MAMMALS OF THE ICE AGE.

For this interesting subject, you are referred to "The Age of Mammals," by Henry Fairfield Osborn, Macmillan, New York, 1921. If there

is a more notable work on the subject, I have not been able to find it. I came across it when, having chanced upon the story of John Conyers and his "elephant," I sought some information on the mammoth. In Mr. Osborn's book, I came across a pleasing wealth of detail. I had had in mind an old picture, a wood cut seen when I was a boy, in which the first discovered mammoth in Siberia was made. My juvenile notions of the beast were that it stood somewhere about 50 feet high. On page 395 of the Osborn book, I find listed under elephants: The true or northern mammoth, *Elep primigenius* 9 feet 6 inches at shoulder. On page 422 there is a reference to the same mammal in the Middle States of North America, and it is noted as having been contemporaneous with the mastodon. On page 420 there is an admirable illustration after the original by Charles R. Knight in the American Museum of Natural History, portraying the hairy mammoth and a Neanderthal man. There is also a description which I copy as follows:

"Mammals of the Third Faunal Zone: The mammoth (E. primigenius) now reaches the height of its evolution and specialization. As preserved in the frozen tundras of northern Siberia it is the most completely known of all fossil mammalia with its undercoat of wool and overcoat of long hair. As recently described by Salensky from the wonderfully complete specimen discovered in 1901 on the banks of the Beresowka River in northeastern Siberia, this animal developed characteristics which absolutely exclude the possibility of its ancestry to the existing Indian elephants. The hind foot is four toed or tetradactyl, and not five toed as in the living forms. The head was larger as

compared with the length of the body than in recent elephants, a character which stands in close connection with the enormous development of the tusks; these were distinguished by their spiral form, the points directed inward. The ears were very small and covered with hair. The tail was relatively shorter than in the existing elephants and was provided with a tassel of long, bristly hair at the end. The color of the hair is a yellowish brown, varying from light brown to pure brown, and a coat of woolly hair 2 to 2½ cm. in length covered the whole body. Interspersed with these were a large number of longer and thicker hairs which formed main-like patches on the cheeks, on the chin, on the shoulders, flanks, abdomen, etc. A broad fringe of this long hair extended along the sides of the body as depicted in the paleolithic sketches from the Combarelles Cave discovered by Capitan and Breuil in 1901. Especially interesting is the food found in the stomach and the mouth, which consists of a meadow flora such as characterizes this region of Siberia at the present day, thus appearing to disprove the theory that the climate was milder than that now prevailing. Nor does it appear that it was more frigid, because there are few representatives of tundra vegetation. Greases and sedges predominate. There were also wild thyme, beans of the wild oxytropis, seeds of the alpine poppy, and the boreal variety of the upright crowfoot, all still found in this region."

As you see, the description is as complete as though a modern living animal was written about. And that is an indication of the whole of the book. The old time dry-as-dust method is abandoned.

There are other surprising facts brought to light. For instance that the mid-Pleistocene of America, like that of Europe developed a "leonine species of cat" (page 485). The skull of it very closely resembled that of the African

lion known to us and was similar to the cave lion of the Old World Pleistocene.

On the disappearance of the horse in America there is an interesting paragraph. As is well known, at the time of the invasion of Cortez into Mexico and of Pizarro into Peru, horses were unknown. Yet, due to the efforts of Professor Marsh, the genealogy of the horse was traced back on this continent, and amply supported by evidence from fossil remains, to the Eohippus, or four toed horse, an animal in which the hind feet retained the vestigial fifth toe. In Pleistocene times, there were at least ten species of horses in different parts of North America, yet all disappeared. The cause of the disappearance has excited wonderment. Equally astonishing of course, is the rapid multiplication of the horse. As to the latter, consider South America and Patagonia, where are herds of wild horses today. Yet as Darwin tells us in his Voyage of the Beagle, Chap. XI, the horse was first landed at Buenos Ayres in 1537, and, the colony being soon deserted, the horse ran wild. Yet, forty-three years later, we hear of them in the neighborhood of the Straits of Magellan.

Osborn has this to say (page 507):

"Among all the problems of Pleistocene extinction presented in America, that of the horses is certainly one of the most difficult. These animals are far superior to the cattle in their adaptability to changed conditions of life and in resourcefulness during severe winter seasons. They were extraordinarily numerous in North America at the beginning of the Pleistocene; at the close of it it appears they were entirely extinct. Similar extinction occurred both in

North and South America in Pleistocene times. It is consequently impossible to connect this phenomenon directly with the Ice Age. In Pleistocene times there was a ready escape to the high plateaux of Mexico, which must have presented all the most favorable conditions for equine life, of climate, soil, and food. The numerous and highly specialized horses of Mexico shared in this extinction. It has consequently ben suggested by the writer and others that the horses may have been swept out of existence by some epidemic disease or diseases. These diseases are carried by flies and favored by moist conditions occurring chiefly during or immediately after heavy rainfalls, though in sporadic cases they may occur at other seasons of the year; such moist conditions occurred periodically in the Great Basin of Oregon and Nevada and in the Valley of Mexico. The disease known in India as 'surra' has a widespread geographic distribution. In Africa there is a similar malady, 'nagana,' or tse-tse fly disease. In Algeria, France, and Spain the horse and the ass are both liable to the attacks of a trypanosome (T. **equiperdum**). In South America the **mal de caderas** affects horses, asses, cattle, and certain other animals, and is attributed to a trypanosome; it is distinctly a wet weather disease, almost completely disappearing in dry seasons. The tse-tse fly of Africa renders thousands of square miles uninhabitable by horses. The rapid rate at which such diseases may travel is illustrated by the spread of the rinderpest, which traversed the whole length of Africa in fifteen years.

"This theory of an epidemic among the American horses during the wet periods of Glacial times receives some support from the discovery by Cockerell in the Miocene insect gauna of Florissant, Colorado, of two species of tse-tse (Glossina) very similar to the African types. The application of the Pleistocene is that a moist or rainy period extending over the Southern States and down into Mexico during Pleisto-

cene times would have favored the distribution of some flies or other parasite-bearing insects, such as ticks, and have resulted in the extinction of the horse."